

5G/6G NTN Programme and In-orbit Experiments

Antonio Franchi
Head of 5G/6G NTN Programme Office

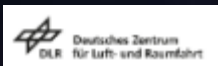


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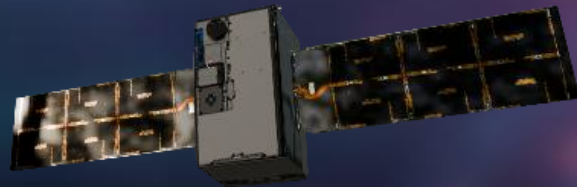
TN/NTN In-Orbit Activities



MIXELS
gNB in space`



Direct 5G Broadband Access Live
Demonstration (LIDE)
Launched July 2025



Time Division Duplexing
Experiment (TIDE)



6G Laboratory In-Orbit
LINO
Launching 2026



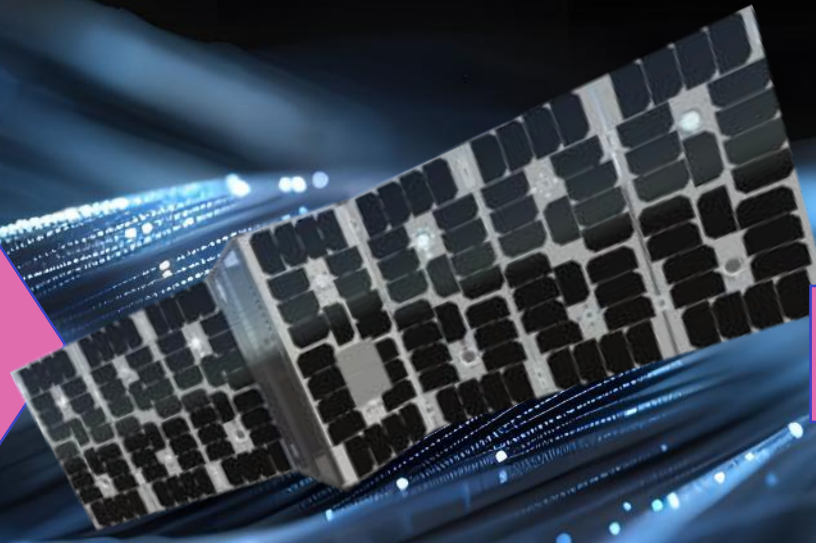
6G Laboratory in Orbit – 6GLINO



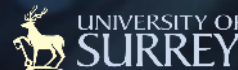
Future Generation of 6G Satellites

AI-assisted DSM
TN-NTN handover
E2E orchestration
6G waveforms
Neuromorphic processors

...



D2D
AI-assisted DSA
Sub-THz transmission
JCAS



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In-Orbit Satellite Testing and Hub Access



Baseline Access:

- Existing configuration
- Space / ground
- Limited support

Free / Nominal cost

Custom Campaign:

- HW / SW Adaptations
- Dedicated support
- Advanced demonstrations

Cost Bands
• 1-3 weeks
• ~ 1 month

Online Expression of Interest
From SNS-JU Project coordinators

Programme Alignment
Innovation / Impact
Feasibility

Thank you

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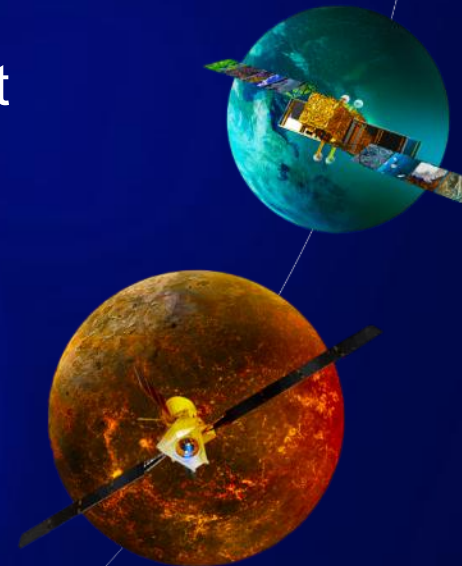
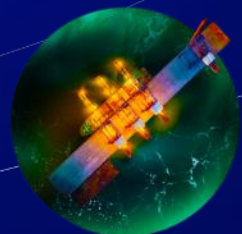
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DEMONSTRATION OF AN EXPERIMENTAL 5G G-NODEB IN SPACE (MIXELS)

THE WAY TO INTEGRATE SPACE AND GROUND NETWORKS

Speaker: V. Schena

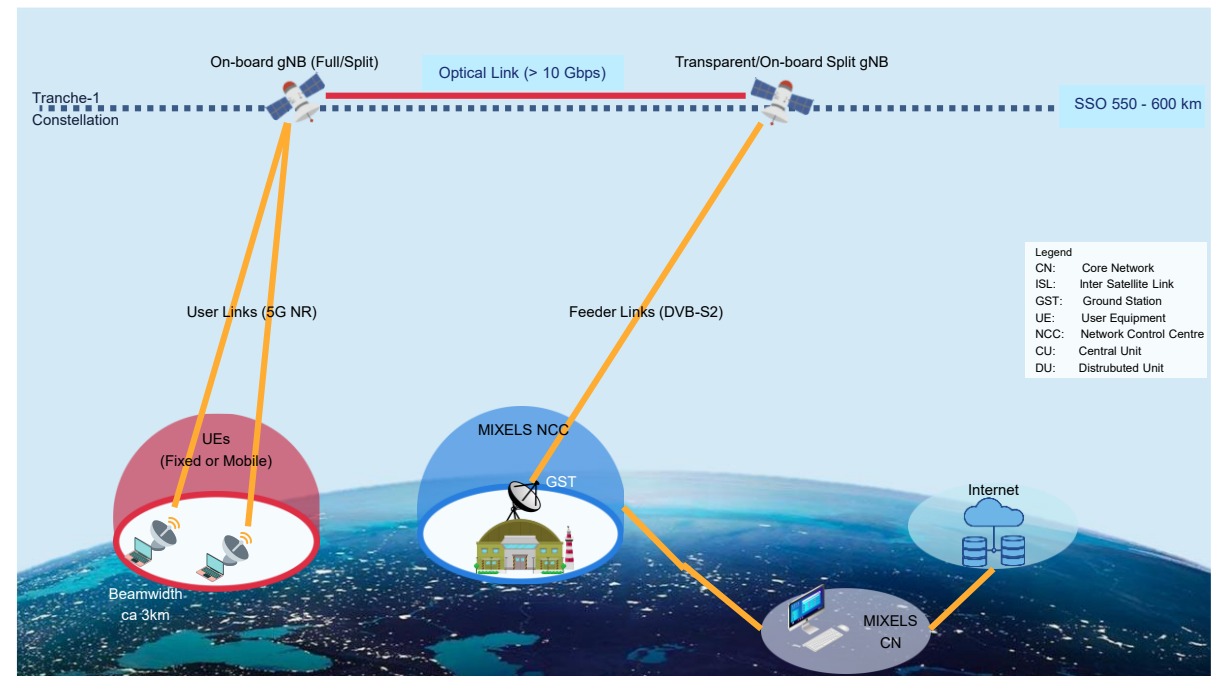


DEMONSTRATION OF AN EXPERIMENTAL 5G G-NODEB IN SPACE (MIXELS)

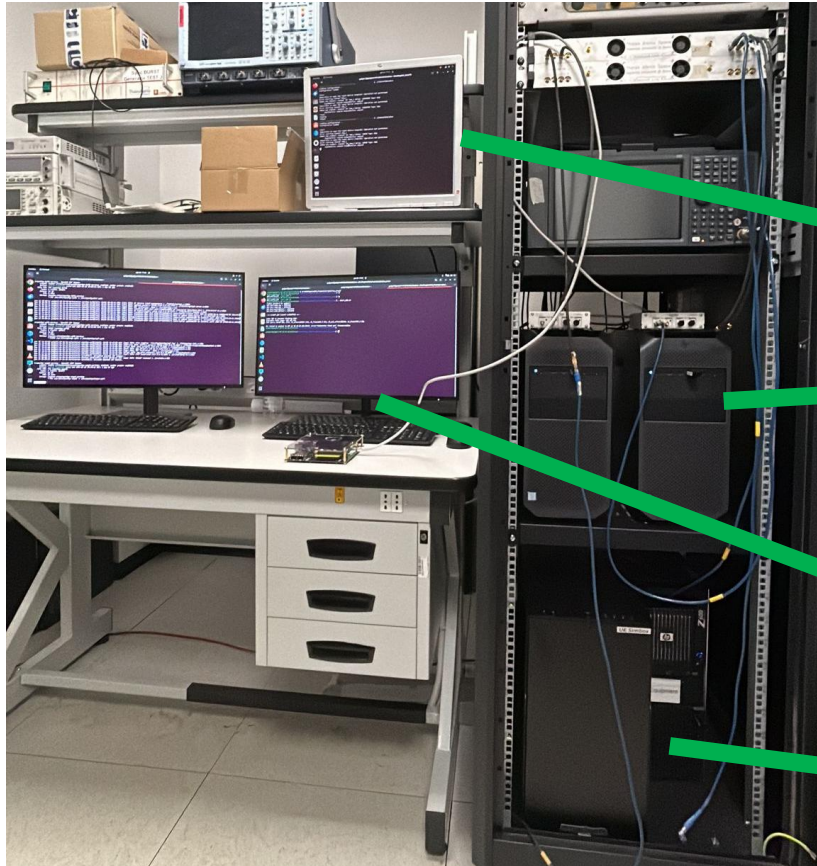
/// MIXELS (Ph1/Ph2)) Project has the objective to develop and demonstrate in orbit an experimental 5G g-NodeB distributed between a regenerative (processed) payload and a satellite gateway. The demonstration will focus on showing the main functionalities of a gNodeB for New Radio Non-Terrestrial Network from LEO.

/// In Perspective, the results of MIXELS Project will be able to be extended also towards MEO and GEO in view of the actual implementation of space networks combined and interacting with the terrestrial network in seamless and transparent way.

/// Currently the Phase 1 has been successfully concluded



MIXELS PH1: LABORATORY TESTBED



MBCE and Spectrum Analyser
Channel Emulator RF and
Spectrum Analyser for Monitoring

Channel Simulator
Delay Simulator at IP
packets running on
dedicated workstation

Workstations and SDRs
GNB and CN software running on
two different Workstation.
SDR ETTUS B210 available

Xilinx Evaluation Board
Evaluation Board that must
emulate the on-board
processing of the in-orbit
satellite



**SW porting on Xilinx
ZCU102 Evaluation
Board emulating the
actual SAT P/L**

UE
5G NTN UE

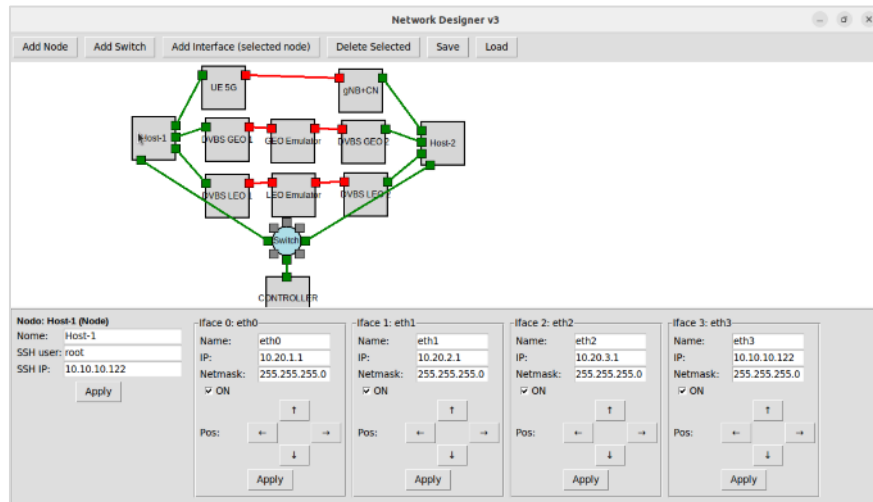
MIXELS PH1: NETWORK DESIGN TOOL

The **Designer Network Tool (DNT)** has been implemented. This defines the network to be simulated in the laboratory, i.e. it defines:

- the number of nodes
- the interfaces
- the networks and subnets
- the connections

The tool is essential for structuring the network architecture in an **intuitive and visual** approach.

The output of DNT is a **JSON file** containing all the network configuration information through a GUI.



```
GNU nano 6.2 current_network.json
{
  "nodes": [
    {
      "type": "node",
      "name": "Host-2",
      "x": 571,
      "y": 84,
      "ssh_user": "root",
      "ssh_ip": "10.10.10.121",
      "switch_network": "",
      "interfaces": [
        {
          "side": "left",
          "offset_index": 0,
          "name": "eth0",
          "ip": "10.20.4.2",
          "netmask": "255.255.255.0",
          "state": true
        },
        {
          "side": "left",
          "offset_index": 1,
          "name": "eth1",
          "ip": "10.20.5.2",
          "netmask": "255.255.255.0",
          "state": true
        },
        {
          "side": "left",
          "offset_index": 2,
          "name": "eth2",

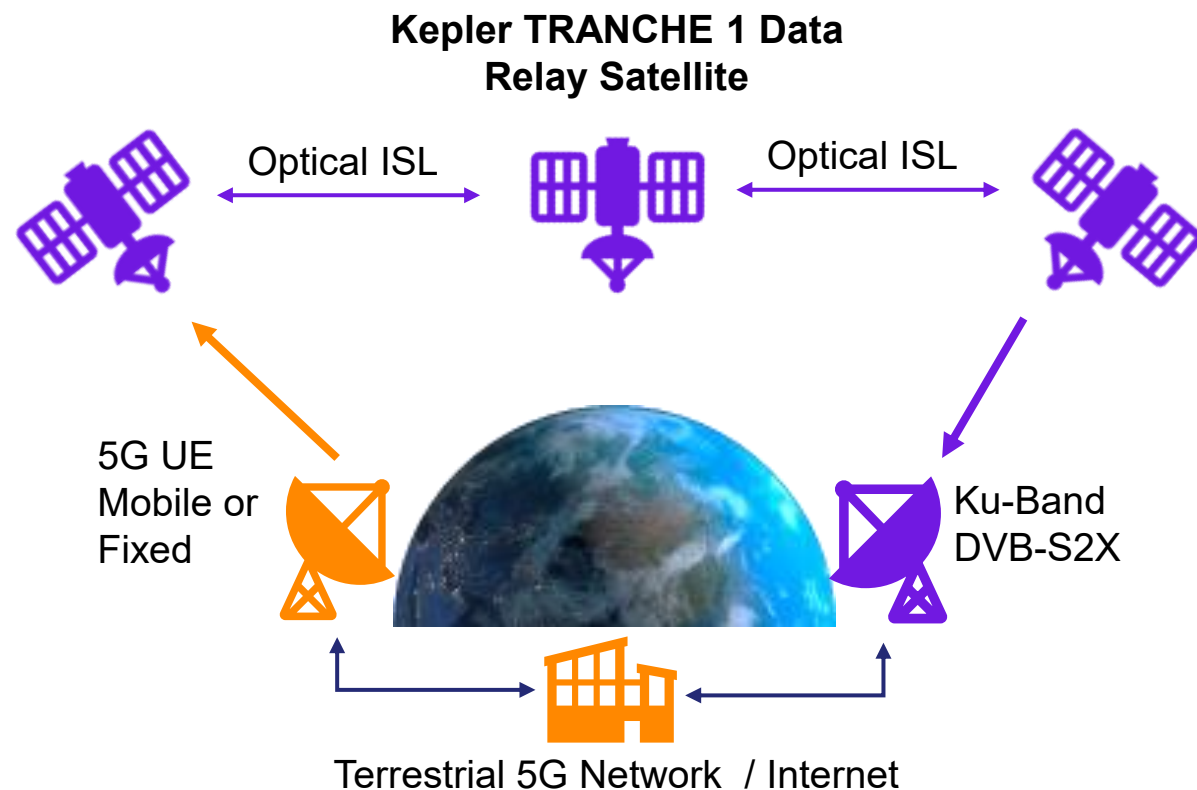
```

MIXELS PH2 DEMOSTATION SCHEME

/// Kepler's Ku-band radio, onboard one of ten constellation satellites, will host the TAS-I 5G workload.

/// Once received, the data will be processed on orbit and re-transmitted as Ethernet packets through the Kepler space network using optical inter-satellite links (ISL)

/// Multiple ISL hops may be required to route the data between the 5G user equipment (UE) and the corresponding Ku-band ground station.



CONCLUSION

- ///MIXELS Project is demonstrating the functionalities of a regenerative gNB in space using professional Low LEO constellation (TRANCHE 1 by KPL) with Edge-Computing on-board and OISL between satellites.
- ///Different functional split scenarios between space and ground and in space have been verified in laboratory and will be tested in DEMO campaigns
- ///Results are expected to provide valuable insights about NTN functionalities envisaged in 3GPP Rel. 17 and 18 and could be used for future standardization activities





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36000 KM

8000 KM

800 KM

700 KM

400 KM

Demonstration of Direct 5G Broadband Access from LEO to Small Aperture Terminals

SNS JU and ESA Joint Workshop

Luca Deva
System Engineering Manager
Tyvak International

Context

- The **5G technology** promises a new paradigm in communications, offering **higher transmission rates and a resilient and secure network**.
- **LEO satellite constellations** are driving the future of global connectivity, **enabling lower latency and improving coverage** in urban/rural areas.
- With the **Release 17**, the 3rd Generation Partnership Project (3GPP) published the first standard to natively incorporate a space element in the communication network, **introducing the concept of 5G Non-Terrestrial Networks (NTN)**

Introduction

- From this context, the project “**Demonstration of direct 5G broadband access from LEO to small aperture terminals**” was developed



In-orbit Demonstration mission focused to demonstrate direct 5G broadband access from LEO to very small aperture terminals executing in-orbit communication experiment.

- **Demonstration Goals:**

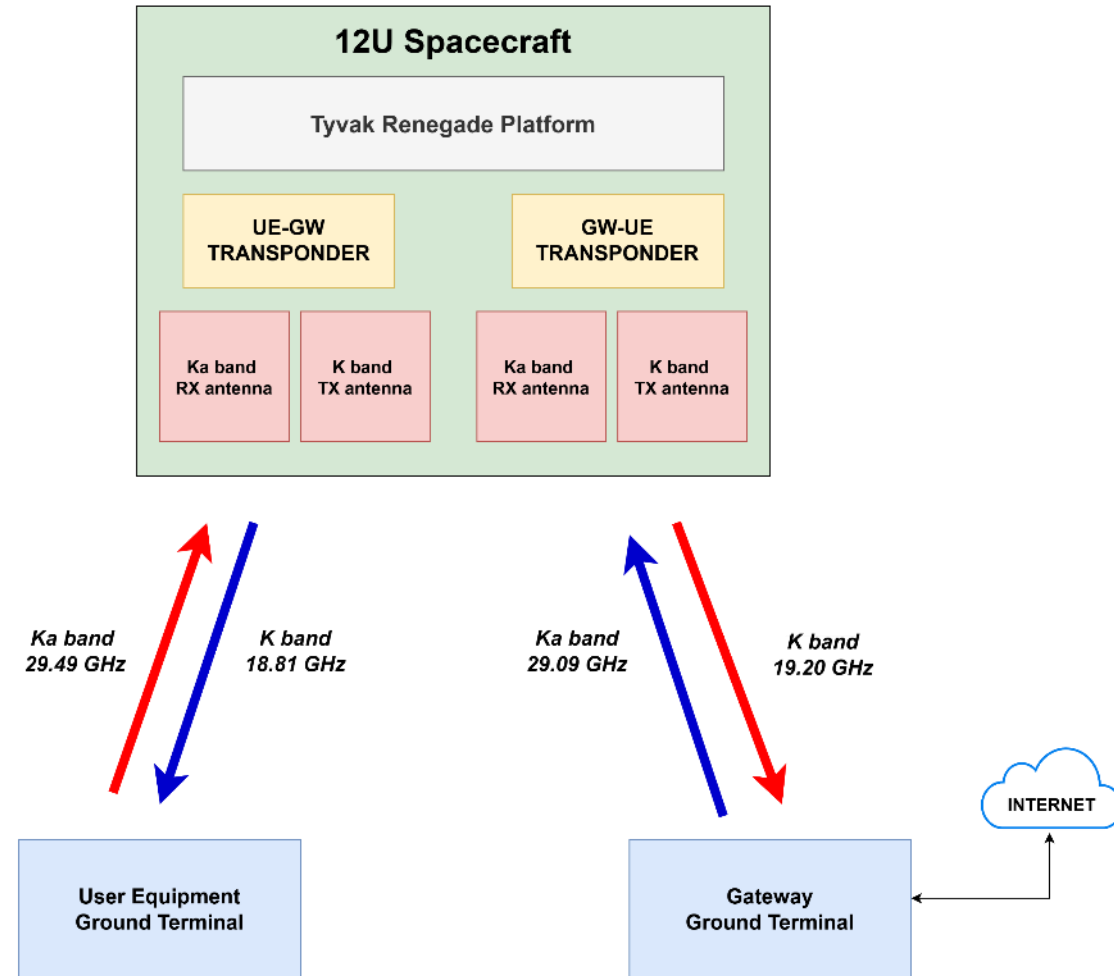
- Link characterization
- Target data rate: 1 Mbps uplink, 10 Mbps downlink

- **Ground segment:**

- Gateway terminal (GW) connected with the internet network
- User Equipment terminal (UE), limited in size and TX power capability
- Two sites selected:
 - Leonessa (Italy)
 - Noordwijk (Netherlands)

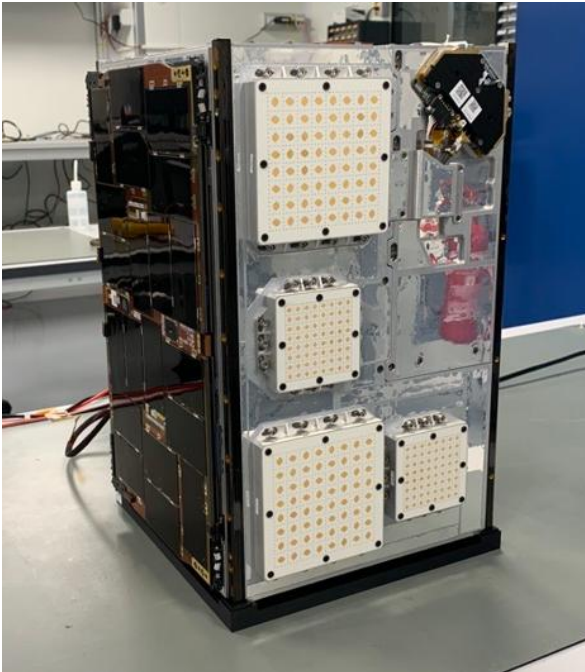
- **Space Segment:**

- Tyvak International 12U Platform
- Payload: 2x Bent-pipe K/Ka transponders, 4x K/Ka antennae



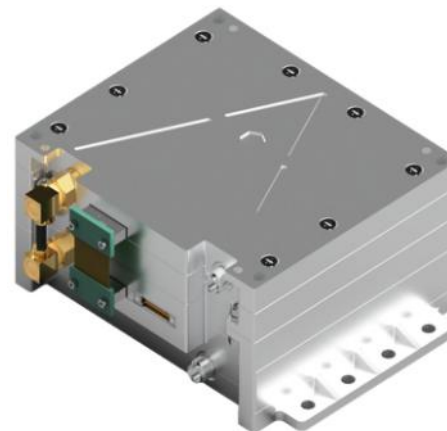
Platform

- Based on Tyvak standard 12U Renegade Platform
- Flight proven avionics with heritage in LEO and BLEO environment



Payload Transponders

- Developed by PICOSATS as redesign of flight proven Ka Band Data Link Transmitter
- Transparent Bend Pipe solution
- Configurable TX and RX center frequencies
- Configurable fixed Gain and AGC logic
- Selected Bandwidth
 - ~10 MHz in GW → UE (Forward link)
 - ~5 MHz UE → GW (Return link)



TYVAK PROPRIETARY

Payload Antennas

- Developed and qualified by PICOSATS in the framework of the program
- Configurable Circular Polarization
- Peak Gain: ~21 dB
- Frequency range:
 - 17-20 GHz (for the downlink)
 - 28-31 GHz (for the uplink)



In-orbit demonstration incremental verification approach:

- **Sensitivity test**

- CW beacon transmission from satellite and CW / 5G PDSCH forwarding ground-to-ground
- Payload performance characterization: in band frequency response and in-out power characteristics
- Supported by ESA Laboratory van equipped with roof-mounted antenna system

- **5G PDSCH reception confirming nominal EVM and SNR**

- Measured via protocol-sensitive GSE

- **Verify 5G synchronization during communication initialization**

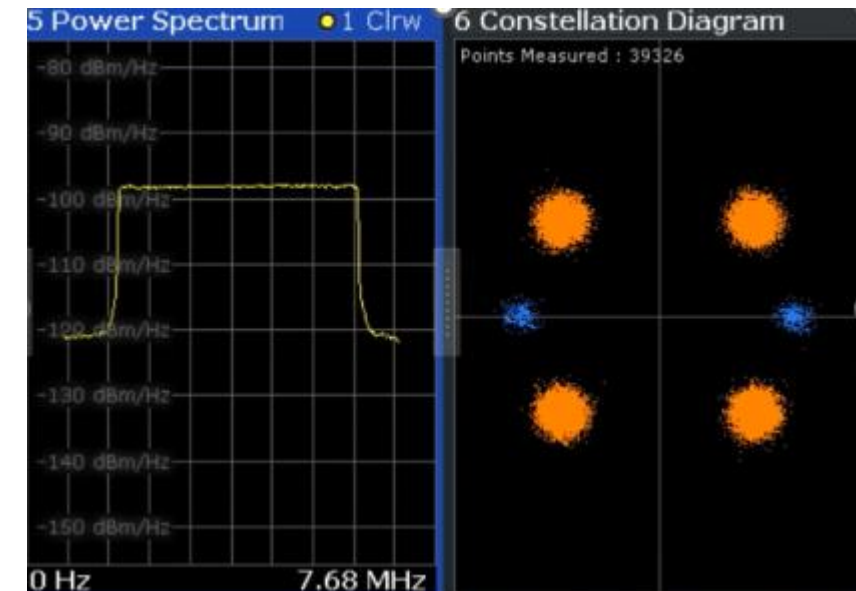
- 5G SSB reception with PSS detection

- **Validate 5G bidirectional communications**

- Amarisoft SW radio stack functionality
- Configuration: 5+5 MHz over single transponder
- Successful 5G UE registration below 7 deg elevation
- Stable connection for the overall pass
- Spectral efficiency measured satisfying the throughput requirements of 1 and 10 Mbps
- Nominal average SNR levels aligned with Link Budget expected values (either for PDSCH, PUSCH and PRACH)



Laboratory van (part of Advanced NTN Telecommunication Laboratory)



In less than year from the launch, LIDE mission collected a lot of interest from the community and the industry, representing a **unique opportunity for in-orbit validation of new technologies under development.**

Mission extension under formalization with the Agency to refine the link characterization and furthermore exploit the LIDE “testbed” capabilities

In conclusion, LIDE achievements highlighted:

- mission **value in demonstrating innovative technologies compliance with the latest 3GPP regulation**, opening new scenarios for the 5G/6G technology
- confirmation of the **advantages associated with the adoption of CubeSat technology** and modular/standardized Platforms in IOD scenarios. Advantages which can be translated in a reduction development and implementation time and the possibility to focus on the demonstration subject